

# Surgical Treatment of Aneurysms and Occlusive Disease of the Aorta

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ANEURYSMS and arteriosclerotic thrombo-obliterative disease of the aorta constitute two of the most common and serious forms of aortic disease. Both conditions are associated with a grave prognosis, producing in most cases disabling symptoms and lethal complications. The former condition results from pressure, rupture and hemorrhage and the latter, from progressive arterial insufficiency, ischemia and gangrene. Until relatively recently, treatment of these lesions has been generally unsatisfactory and, at best, palliative. During the past few years, however, efforts have been directed toward a more effective form of therapy consisting of removal of the lesion and restoration of function either by aortic repair or by insertion of aortic homografts. To be sure, it has not been possible to apply this form of therapy in all cases encountered, but our experience,<sup>4-7</sup> like that of others,<sup>1-3,8,12,16</sup> has convinced us that it is the treatment of choice and can be employed much more frequently than previously realized.

Certain factors—particularly the nature and extent of the lesion and its location—have an important bearing on the successful application of this form of therapy. In general, aneurysms of the aorta are usually of two types, sacciform and fusiform. The former

*Aneurysms and arteriosclerotic thrombo-obliterative disease of the aorta constitute two of the most common and serious forms of aortic lesions for which treatment has been generally unsatisfactory. Recently, however, a procedure has been developed wherein the lesion is extirpated and function restored by aortic repair or insertion of homografts. The gratifying results obtained by this method of therapy based on an experience with 41 cases suggests it is the most effective approach to the problem.*

arise most frequently in the thoracic aorta, usually about the arch and great vessels, with syphilis being the underlying disease in most cases. Fusiform aneurysms are most commonly encountered in the abdominal aorta with arteriosclerosis as the most common underlying pathologic process. It has long been recognized that this type of aneurysm most frequently involves the segment of abdominal aorta between the origin of the renal arteries and the bifurcation. Interestingly enough, this is also the segment of aorta most frequently involved in arteriosclerotic thrombo-obliterative disease of the aorta.

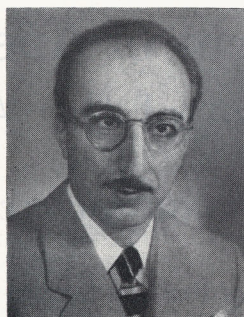
The pathologic features of sacciform aneurysms of syphilitic origin include a relatively small neck and a surrounding aortic wall with a leathery consistency suitable for suture. Because of these features, excision can often be done without encroachment upon the aortic lumen.<sup>4,7</sup> It is accomplished by tangential occlusion of the neck of the sac with a clamp, excision of the aneurysm distal to the clamp and lateral arteriorrhaphy to repair the aortic

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defect, thus preserving continuity of the aorta. Under these circumstances the aorta is not involved in its entire circumference by the pathologic process, and sufficient relatively normal tissue is available for satisfactory repair of the defect. A similar procedure may



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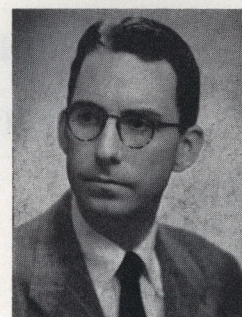
also be used when the aneurysm involves the major vessels of the aortic arch even though they may be fusiform in type. Because it may be necessary in such cases to sacrifice the involved vessel, it is important to determine beforehand the possible ischemic effects of occlusion of these vessels, particularly of the carotid arteries.

In the resection of fusiform aneurysms of the aorta the problem is somewhat different, because such lesions usually involve the entire circumference of the aorta for a varying distance. Accordingly, extirpation of these lesions requires excision of a varying segment of the aorta itself along with the aneurysm. Under these circumstances, temporary arrest of the circulation in the aorta distal to the origin of the aneurysm must be done during aneurysmectomy, and the resulting defect in the aorta must be bridged to restore normal circulation. This may be accomplished satisfactorily by means of preserved aortic homografts. Various methods of preservation may be used for this purpose. In our early experience the homografts were preserved in nutrient media at a temperature of 0 to 4° C. More recently, however, in the last 26 cases, we have used freeze-dried aortic homografts and have been impressed with the advantages of this method of preservation.

An important consideration in the performance of this procedure is the potential ischemic effects of the temporary arrest of the circulation on the tissues distal to the point of occlusion, especially in the spinal cord and kidneys. The safe period for occlusion of the aorta at this level has not been accurately determined, but, on the basis of our limited experience<sup>5,7</sup>



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and that of others<sup>2</sup> with a few cases of aneurysms of the descending thoracic aorta, it has been found possible to occlude the descending aorta for periods up to 58 minutes without evidence of cord or renal damage. Fortunately, most aneurysms requiring this procedure arise in the abdominal aorta below the origin of the renal arteries, and there is usually sufficient margin of aorta between these vessels and the aneurysm to permit application of the occluding clamp without interruption of blood flow to the kidneys. Occlusion at this level for periods averaging about one hour, but in one case as long as two hours, has not been followed by any evidence of ischemic changes in the pelvis or lower extremities. This matter is of little or no importance in thrombo-obliterative disease of the aorta because of the well-established collateral circulation.

Technical considerations of the operative procedure of resection of aneurysms of the aorta with replacement by aortic homografts have been previously presented.<sup>4-7</sup> A left thoracoabdominal approach through the resected bed of the ninth or tenth rib is used for aneurysms involving the lower thoracic and upper abdominal aorta. For aneurysms arising in the abdominal aorta below the origin of the renal arteries an abdominal approach through a midline incision is preferred. The application of this procedure may be illustrated by the following brief case report:

*Case 1*—W. M., a 73 year old iceman, was admitted to the hospital on September 16, 1953, complaining of pain and a pulsating mass in the abdomen.

Five years previously he was seized, while at work, with a severe abdominal pain which



caused him to fall to the ground. The pain lasted about 30 minutes. Shortly thereafter, the patient detected a pulsating mass in the abdomen which "felt like my heart had fallen into my belly." For two years he had suffered from hemorrhoids and rectal prolapse.

Physical examination revealed that the patient was well nourished and vigorous in appearance. Blood pressure was 140/80. The cardiorespiratory systems were normal. The abdomen was slightly protuberant, and a pulsating mass was visible in midabdomen to the left of the midline. Palpation revealed this mass to be approximately 20 by 12 cm. in size. Its superior margin extended into the epigastrium and beneath the left costal margin, and inferiorly, it extended into the suprapubic region. Pulsations were expansile. A systolic murmur was audible over the mass. Arterial pulses were present in the lower extremities.

Rectal examination disclosed external and internal hemorrhoids and a moderate rectal prolapse. Diagnoses were as follows: (1) aneurysm of the abdominal aorta; (2) hemorrhoids and rectal prolapse.

Results of blood and urine examinations were normal. A roentgenogram of the abdomen showed calcification in the wall of the aneurysm and indicated that from the superior limits of the calcification the aneurysm arose below the renal arteries.

On September 24, 1953, an operation was performed with the patient under general anesthesia. The abdomen was opened through a midline incision centered on the umbilicus. A large fusiform aneurysm of the abdominal aorta was found which extended from the renal arteries distally to include the aortic bifurcation (figure 1). The posterior parietal peritoneum was incised and the ligament of Treitz divided. The aorta was freed just below the renal vessels, and both common iliac arteries were isolated. The occluded inferior mesenteric artery was divided. The aorta above and the iliac arteries below the aneurysm were occluded with vascular clamps, and the aneurysm was excised (figure 2). The defect in the abdominal aorta was bridged with a freeze-dried abdominal aortic homograft. Anastomosis was accomplished with a continuous over-and-over

suture of 0000 arterial silk (figure 3). Total time of aortic occlusion was 78 minutes. Upon completion of the aortic transplantation, bilateral lumbar sympathectomy and appendectomy were performed.

Convalescence was uneventful. Within 24 hours pedal pulses were palpable. Ambulation was begun on the second postoperative day, and the patient was discharged in good condition on October 10, 1953.

We have now operated on 26 consecutive cases of aneurysms of the abdominal aorta with the intention of performing this procedure, i.e., resection with replacement by aortic homograft. It was possible to perform the procedure in all but one case. This single exception concerned a patient whose fusiform aneurysm involved virtually the entire abdominal aorta. Under these circumstances aneurysmectomy would have necessitated interruption of all visceral blood supply and, accordingly, was considered impractical.

In this series of 25 cases of aneurysmectomy, the majority of patients were men in the seventh decade, and 4 were over 70 years of age. The aneurysms were arteriosclerotic in origin in all but 1 case in which syphilis was considered the causative factor. The bifurcation was involved, requiring excision and the use of a bifurcation homograft in all but 3 cases. In 2 patients the aneurysm had ruptured, producing severe hemorrhage and shock, and the operations were performed as emergency procedures. Hypertension of moderate to severe degree was present in 7 patients. All 25 patients showed varying degrees of atheromatous changes and roentgenologic evidence of calcification in the aorta.

On the basis of experience from this series the impression has been gained that none of the factors mentioned necessarily constitute a contraindication to operation and that major contraindications are concerned with severe impairment of vital functions, involving cardiopulmonary and renal organs.

The operation itself seemed to be well tolerated by all the patients, although 5 died subsequently—2 from severe coronary disease, 2 from renal failure and progressive uremia, and 1 from pulmonary embolism. All of



the other patients have been completely relieved of their symptoms, and their general conditions have shown progressive improvement. Of particular significance is the fact that most of them seemed to have improvement in circulation in the lower extremities.

The operative procedure described for aneurysms of the abdominal aorta may also be employed effectively for thrombo-obliterative disease of the aorta. This condition, which has been termed Leriche's syndrome, or insidious thrombosis of the aortic bifurcation, apparently develops on the basis of arteriosclerotic changes with atheromatous plaques and calcified ulcerated areas in the intima leading to thrombus formation. These changes ultimately produce stenosis and as a result of the superimposed thrombotic process lead to complete occlusion of the lumen. Not infrequently, as observed by Leriche,<sup>13,14</sup> these arteriosclerotic changes begin in the iliac arteries near the bifurcation with progressive thrombus formation propagating upward to occlude completely the aortic lumen. In some instances, this obliterative process progressively extends up as high as and even above the origin of the renal arteries, resulting in death from hypertensive cardiovascular disease and uremia.

The disease is characterized by an insidious and slowly progressive development with symptoms of intermittent claudication, pain, easy fatigability particularly in the hips and legs, and sexual impotency. Physical findings include manifestations of arterial insufficiency in the lower extremities with absence of pulsations and usually a systolic murmur in the

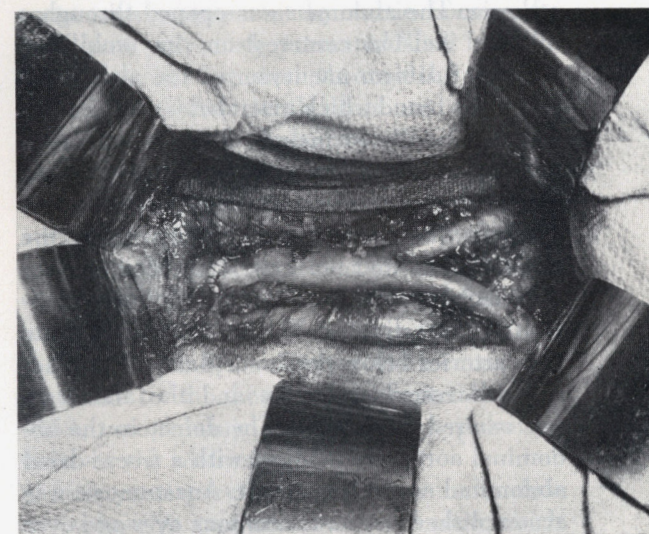
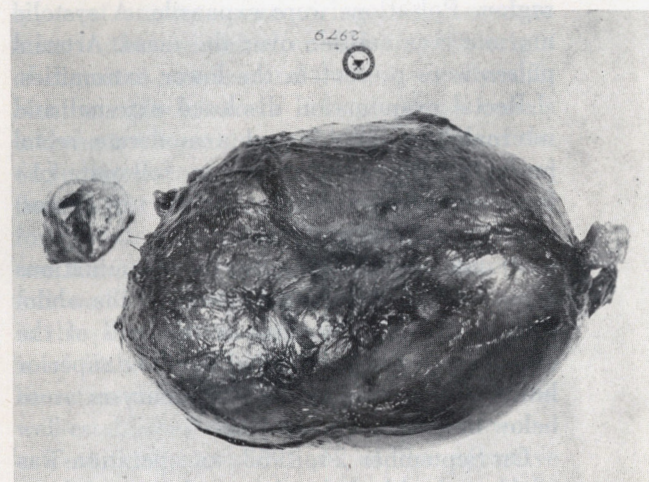
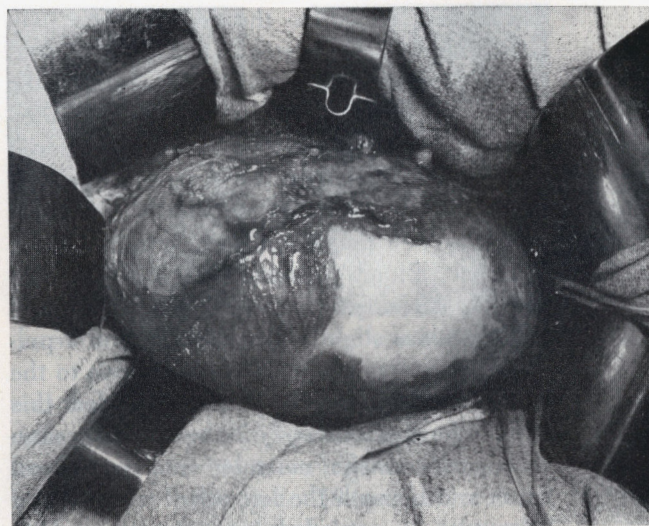


FIGURE 1 (*top*). Photograph taken during operation in case 1, showing huge aneurysm of abdominal aorta after it had been freed from surrounding structures. Umbilical tapes are shown encircling the aorta above the aneurysm and the common iliac arteries below.

FIGURE 2 (*center*). Photograph of aneurysm of abdominal aorta after excision in case 1, showing stumps of iliac arteries on left and additional segment of excised aorta on right, and revealing extensive atheromatous changes.

FIGURE 3 (*bottom*). Photograph made at operation in case 1 after resection of aneurysm of abdominal aorta and completed anastomosis of bifurcation aortic homograft to aorta proximally and iliac arteries distally.



abdomen. The diagnosis may be readily confirmed by aortography (figure 4).

Although the condition is slowly progressive, sometimes over a period of 5 or 10 years, the ultimate prognosis is grave with most patients dying of the complications of the disease. Until relatively recently, treatment has not been satisfactory and, at best, is palliative. It consists essentially of lumbar sympathectomy.<sup>9, 10, 14, 15, 17</sup> Thrombo-endarterectomy, designed to remove the diseased intima and restore a normal arterial lumen has yielded better results in some instances.<sup>11, 18</sup> In our experience, however, mural changes have usually been so extensive about the bifurcation as to preclude the use of this procedure under these circumstances. For this reason, extirpation of the diseased segment with restoration of continuity by aortic homograft, as originally proposed by Leriche, is believed to provide a more effective therapeutic approach to the problem. The successful application of this procedure is illustrated by the following brief case report:

**Case 2**—J. M., a 58 year old white man, was admitted to the hospital on October 18, 1953, complaining of abdominal pain, tarry stools, and cramping pain in the lower extremities.

The patient had been under medical treatment for a duodenal ulcer since 1937 and had been hospitalized several times for intractable pain. In recent months he had noted tarry stools on several occasions.

In 1948, cramping pain developed in his left calf when he walked. The pain soon involved the entire left lower extremity, and within the past year the right lower extremity had become similarly affected. The pain was relieved by rest. During the past three years the patient had been impotent.

Physical examination revealed a blood pressure of 190/120. The heart was slightly enlarged to the left. There was moderate epigastric tenderness and a loud systolic murmur was audible in the upper abdomen. The lower extremities showed moderate loss of subcutaneous fat and no pulses were palpable.

Urinalysis and hemogram were within normal limits. Barium study of the upper gastro-

intestinal tract revealed a duodenal ulcer. Translumbar aortography showed occlusion of the abdominal aorta and common iliac arteries from a point just below the renal arteries (figure 4).

On October 15, 1953, an operation was performed under continuous spinal anesthesia. The peritoneal cavity was entered through a midline incision extending from just below the xiphoid to well below the umbilicus. The preoperative diagnoses of duodenal ulcer and aortic thrombosis were confirmed. A 70 per cent gastric resection and a Billroth I gastroduodenostomy were performed first.

The posterior parietal peritoneum was then incised, the ligament of Treitz divided, and the aorta and iliac arteries mobilized. The occluded inferior mesenteric artery was divided between ligatures. Clamps were applied to the aorta slightly below the renal arteries and to the common iliac arteries, and the aorta and bifurcation were removed (figures 5 and 6).

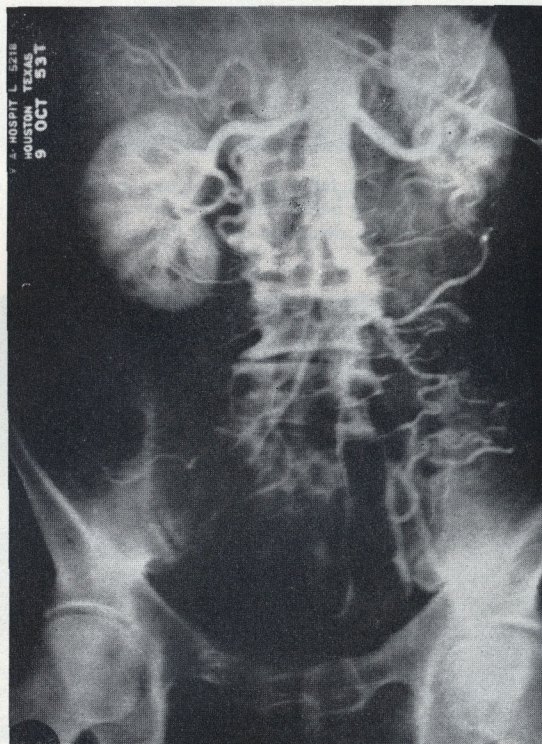


FIGURE 4. Aortogram in case 2, showing complete occlusion of the abdominal aorta beginning just below the origin of the renal arteries.





FIGURE 5. Photograph taken during operation in case 2, showing mobilized abdominal aorta with umbilical tapes encircling iliac arteries below and aorta above, immediately below overlying left renal vein. Note roughened irregular surface of aorta and dense periaortic fibrosis.



FIGURE 6. Photograph of excised segment of abdominal aorta and bifurcation in case 2, showing complete occlusion of lumen and additional segment of organized thrombus projecting above level of divided aorta and removed from proximal aortic stump.



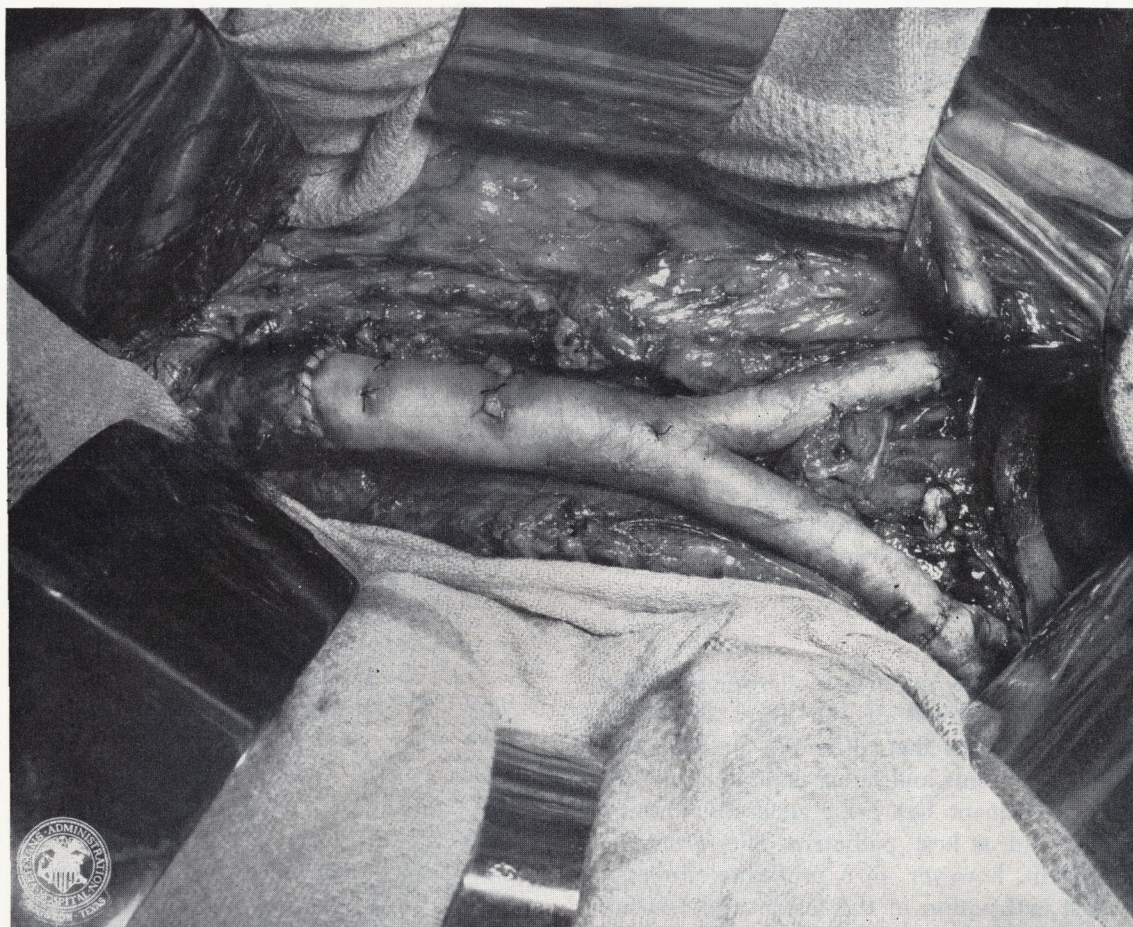


FIGURE 7. Photograph made at operation in case 2 after resection of obliterated segment of aorta and replacement with aortic homograft.

The proximal aortic lumen was found to be partially occluded by an atheromatous plaque and a soft thrombus. Therefore, a clamp was applied above the renal arteries, the atheroma and thrombus removed, the lumen flushed with saline solution, and a clamp reapplied below the renal arteries; then the clamp above the renal arteries was removed. The lumens of the iliac arteries were occluded by organized thrombi. They were stripped out of the lumen distally to the iliac bifurcations where vigorous back flow was encountered. A reconstituted, freeze-dried homologous aortic Y graft was inserted into the defect, using a continuous over-and-over suture of 0000 arterial silk (figure 7). The total time of aortic occlusion was one hour. Following removal of the

clamp, pulsations were detectable in both femoral arteries.

Bilateral lumbar sympathectomy and appendectomy were performed following the completion of the aortic graft.

Within 24 hours after operation bounding pedal pulses were present. Convalescence was uneventful except for a moderate degree of postural hypotension which was relieved by compression bandages applied to the lower extremities.

We have now employed this procedure in 11 cases of arteriosclerotic thrombo-obliterative disease of the aorta. In one of the patients the oblitative process was located in the lower thoracic and upper abdominal aorta, and in the remainder of the patients it in-



volved the terminal portion of the aorta and bifurcation. All of these patients recovered; most of them showed striking improvement in circulation of the lower extremities with return of peripheral pulses and disappearance of previous signs of arterial insufficiency.

In addition to these 36 cases of aneurysms and occlusive disease of the abdominal aorta treated by resection and replacement with aortic homografts, we have used this procedure in 5 cases with involvement of the thoracic aorta. Two of these patients had huge syphilitic aneurysms producing erosion of the vertebrae; two had aneurysms in association with coarctation; and one had arteriosclerotic thrombo-obliterative disease. All of these patients recovered with complete relief of symptoms, and only one showed transient weakness of the lower extremities.

### Summary

1. Aneurysms and arteriosclerotic thrombo-obliterative disease of the aorta constitute serious disorders that ultimately produce disabling symptoms and lethal complications for which treatment has been generally unsatisfactory and, at best, palliative. The recent development, however, of a procedure directed toward extirpation of the lesion and restoration of function by aortic repair or insertion of aortic homografts is believed to provide a more effective form of therapy.

2. The successful application of this form of therapy is dependent primarily on the type, extent and location of the lesion. Sacciform aneurysms, for example, which usually involve the thoracic aorta and in which the neck is relatively small and the surrounding aortic wall is suitable for suture, may be excised by tangential occlusion of the neck and lateral aortorrhaphy. Fusiform aneurysms, on the other hand, because of their tendency to involve the entire circumference of the aorta for a varying distance, usually necessitate excision of a segment of the aorta itself with replacement by aortic homograft to restore normal circulation. A similar procedure may also be employed in thrombo-obliterative disease of the aorta.

3. This procedure of excision and replacement with aortic homografts has now been performed in a total of 41 cases, the lesions being aneurysms in 30 and thrombo-obliterative disease of the aorta in 11. There were 5 deaths in this series. All of the other patients showed striking improvement or complete relief of symptoms.

4. Although further experience and longer follow-up observations are required for final evaluation, early gratifying results obtained with this method of therapy provide good reason to believe that it is presently the most effective approach to the problem of aneurysms and thrombo-obliterative disease of the aorta.

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